Case Report

Infrared flashing light through the cricothyroid membrane to guide flexible bronchoscopic tracheal intubation

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Summary

Flexible bronchoscopic tracheal intubation is a fundamental technique in the management of the difficult airway but requires specific skills which may be both difficult to achieve and maintain. Therefore, techniques to improve its success should be developed. We present two cases, one where the ear, nose and throat surgeon could not view the glottis due to laryngeal pathology, and one where pathology in the oropharynx obscured access to the trachea during attempts at flexible bronchoscopic and videolaryngoscopic tracheal intubation. In both cases, tracheal intubation was subsequently successful due to the use of the Infrared Red Intubation System. This is an infrared light source that is secured to the anterior neck. It emits a flashing infrared light that is captured by the flexible bronchoscope, thus guiding the way to the trachea. These are the first reports of this technology being used for flexible bronchoscopic tracheal intubation in patients with severe airway pathology where conventional approaches had failed. Both cases emphasise that this technique can be of benefit in avoiding a surgical airway.

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Introduction

Flexible bronchoscopic tracheal intubation is a fundamental technique in the management of the difficult airway, both expected and unexpected. It has a high success rate, and despite increased availability of videolaryngoscopy it remains an essential anaesthetic skill [1-3].

Patients with neck pathology frequently have an airway that is difficult for the anaesthetist to manage [1, 2, 4]. When airway management is predicted to be difficult, awake tracheal intubation has several advantages and should be considered [5]. However, flexible bronchoscopic tracheal intubation requires advanced skills which are difficult to both acquire and maintain. Therefore, techniques and adjuncts that may improve success with flexible bronchoscopic tracheal intubation should be developed and studied.

Infrared light guidance with the Infrared Red Intubation System (IRRIS) (Guide In Medical, Nazareth, Israel) may 'guide' the bronchoscope into the trachea, especially in airways where the anatomy is distorted [6]. This technique may be of assistance to experts as well as novices [7].

The IRRIS is a battery powered, multiple use, infrared light source. It has a size of 3 × 4 × 2 cm, weighs 30 g and is attached with adhesive tape to the anterior neck over the patient's cricothyroid membrane or trachea. The IRRIS emits a flashing infrared

light that is not visible to the naked eye but can be captured by the video systems of a suitable flexible bronchoscope. The light is emitted through the patient's skin into the subglottic space and is seen on the screen as white flashing light from the trachea, thus guiding the proceduralist when advancing the bronchoscope (Fig. 1). The infrared light does not affect the skin of the patient [7, 8]. The technique for the use of this device as an adjunct to straightforward flexible bronchoscopic tracheal intubation has been described [9]. However, use of IRRIS in patients with airway pathology was so severe that it prevented view of the trachea and resulted in abandoning videolaryngoscopy or flexible endoscopy has not been reported previously.

Report

Patient 1

A 70-year-old, 180-cm, 91-kg man with a previous history of temporary tracheostomy and radiotherapy for laryngeal cancer presented for a diagnostic biopsy. Pre-anaesthetic nasendoscopy by the surgeon revealed a "*hypopharynx with phlegm and inability to visualise the vocal cords due to a pronounced swelling at the aryepiglottic fold*". Pre-operative airway assessment revealed a mouth opening > 4 cm; modified Mallampati class 1; normal neck extension; thyromental distance > 6 cm; and an ability to extend the lower jaw. Neither the cricothyroid membrane nor the trachea were identifiable by palpation due to the post-radiation fibrosis. An awake flexible bronchoscopic tracheal intubation was planned.

The midpoint of the cricothyroid membrane was marked using ultrasound guidance [10] and the IRRIS was placed on the skin superficial to this mark. After intravenous (i.v.) administration of 200 µg glycopyrronium as an antisialagogue, and light sedation with 1 mg i.v. midazolam and an infusion of remifentanil 500 µg.h $^{\hbox{-}1}$. Topical anaesthesia of the airway was achieved by applying 12 sprays of lidocaine 10% via a long mucosal atomising device to the larynx, followed by 2 ml of lidocaine 4% via the spray channel on the bronchoscope to the trachea. Tracheal intubation was then attempted using a disposable flexible bronchoscope with a 3.8-mm outer diameter (Ambu aScope^{TM} Broncho Slim, Ambu A/S, Ballerup. Denmark), mounted with a 6.0-mm internal diameter tracheal tube.

After several attempts, the anaesthetist succeeded in advancing the bronchoscope and the tracheal tube into the distal trachea and past a triangular tracheal stenosis after previous tracheostomy, guided by the flashing light visible from within the larynx (see Online Supporting Information Video S1). Subsequent railroading of the tracheal tube into the trachea was straightforward. The biopsy confirmed recurrent malignancy and the patient's trachea was successfully extubated. Weeks later,

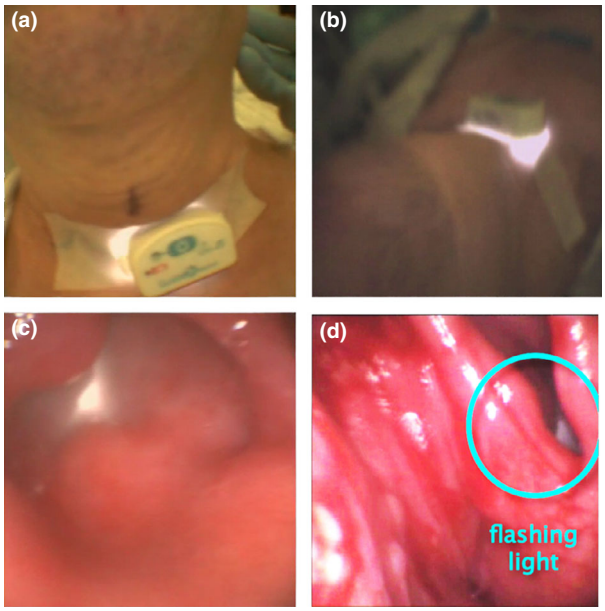

Figure 1 The IRRIS device placed on the neck, superficial to the cricothyroid membrane in Patient 1 (a) and Patient 2 (b). The light is seen emerging from the trachea, thus showing the path to follow with the flexible bronchoscope, beyond the pathological changes in pharynx and larynx in Patient 1 (c) and Patient 2 (d). Images are recorded with the flexible bronchoscope thus the infrared becomes visible and is seen as a flashing white light.

the patient had laryngectomy preceded by awake nasotracheal intubation in which the IRRIS was again considered key to the successful advancement of the bronchoscope (see online Supporting Information Video S1).

Patient 2

A 75-year-old, 64.5 kg man presented after a computer tomography scan showed a lesion suspicious for oropharyngeal cancer, with associated oedema at the base of the tongue and epiglottis. He had refused pre-operative diagnostic transnasal flexible endoscopy. Pre-operative airway assessment revealed mouth opening > 4 cm, modified Mallampati class 1; normal neck extension; thyromental distance > 6 cm and the ability to extend the lower jaw. The cricothyroid membrane was identifiable by palpation and was marked before induction of anaesthesia. At the request of the patient, who was informed of and had accepted the additional risk, anaesthesia was induced before airway management the airway was secured.

Following induction of anaesthesia with i.v. fentanyl 100 μg and propofol 130 mg, the patient's lungs were easily bag and mask ventilated. The patient received an i.v. bolus of 240 μg remifentanil before videolayngoscopy (McGrath™ Mac with X-blade, Medtronic, Minneapolis, USA) revealed a swollen base of the tongue and large epiglottic process obstructing a view of the vocal cords. Anaesthesia was maintained with an i.v. infusion of propofol 400 $mg.h^{\hbox{-}1}$ and remifentanil 3 $mg.h^{\hbox{-}1}$. A second anaesthetist also attempted videolaryngoscopy, but this was abandoned after three attempts. Subsequently a flexible bronchoscope with a 3.8-mm outer diameter (Ambu aScope™ Broncho Slim, Ambu A/S, Ballerup. Denmark) was introduced via the nares with hardly any recognisable anatomy visible, with accidental oesophageal placement. A combination of the flexible bronchoscope via the nares and the videolaryngoscope placed orally was also attempted without success.

Finally, the IRRIS was placed on the skin over the pre-identified cricothyroid membrane. Subsequently, it became possible to 'follow' the flashing light to the trachea with the bronchoscope inserted via the nares. This was followed by easy railroading of a 5.5-mm internal diameter tracheal tube. Postoperatively the patient's trachea was extubated with the patient fully awake (see online Supporting Information Video S1).

Discussion

These are the first reports of IRRIS being used for flexible bronchoscopic tracheal intubation in patients where the airway pathology was so severe that view of the vocal cords was not possible. The procedure was abandoned by the surgeon (Patient 1) and an experienced anaesthetist (Patient 2). The videos recorded from the flexible bronchoscope demonstrate the difficulty of these procedures with severe pathology and poor view of the glottis, and the extent to which the successful management was eventually facilitated by IRRIS.

Patient 1 was scheduled for an awake flexible bronchoscopic tracheal intubation as induction of anaesthesia before securing the airway was perceived to have carried an unacceptably high risk of failure. A rescue cricothyrotomy in this patient would have been difficult due to the severe post-radiation fibrosis. Because of the post-radiation fibrosis an awake tracheostomy would have been arduous to perform, unpleasant for the patient, maybe even unsuccessful due to the concomitant tracheal stenosis. The severe pathology made advancement of the flexible bronchoscope to the trachea challenging during both the oral and the nasal approach. In both instances, guidance by the light emerging from the laryngeal inlet was crucial in accomplishing the eventually successful intubation.

In the case of Patient 2, we did not expect difficult bag and mask ventilation. However, due to the known pathology at the base of the tongue and epiglottis we did expect difficult tracheal intubation. The preferable solution would have been to manage the airway with an awake technique [4], but at the request of the patient, anaesthesia was induced before attempting definitive airway management. Several attempts were made to manage the airway, all without success. Not until the IRRIS was placed did it become possible to guide the tracheal tube into the trachea.

The application of the IRRIS as a guide to flexible bronchoscopic tracheal intubation was first described in a retrospective case series of 10 patients. The patients represented a heterogeneous mixture of orally or nasally intubated patients whose tracheas were intubated either awake or asleep and either orally or nasally, and some with pathology of the airway. It was concluded that "*the addition of the IRRIS technique to intubation of difficult airways with video techniques may be a tool that will make intubation of the most difficult airways with pathology and distortion easier*" [6]. We found an additional two reports of the use of IRRIS in the literature [7, 8]. These reports demonstrated successful use of the technique for rigid video laryngoscopic tracheal intubation in lean [8] and obese [7] anaesthetised patients without airway pathology and suggested that time to tracheal intubation is reduced and first pass success is increased [8].

Both of our cases emphasise that in patients with severely difficult airways, IRRIS can be of benefit and may even enable tracheostomy to be avoided. A controlled study in patients with difficult airways is needed before we can definitively assess the advantages and disadvantages of IRRIS for routine use.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Video S1. Infrared flashing light through the cricothyroid membrane to guide flexible bronchoscopic tracheal intubation. (a) and (b) Patient 1; (c) Patient 2.

